



## 2011 Annual Report

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# A MESSAGE FROM THE OFFICE OF THE EXECUTIVE AGENT

*"I have recently had the opportunity to visit a variety of DoD installations in the U.S. and overseas, and I see firsthand the commitment to energy security, environmental sustainability, and a world-class safety culture. For example, the Army is piloting our net zero initiative at 17 installations, comprehensively addressing energy and water usage and waste generation challenges. This combined with focused safety and health initiatives across the DoD will ultimately pave the way for the DoD to target net zero energy, net zero water, net zero waste, and zero mishaps. Through creative engineering, strategic partnerships, and culture change, we can realize significant cost savings, while providing our warfighters and civilians with a quality work environment and sustainable future. Achieving net zero is a personal mission; I am proud of the efforts of the NDCEE and other collaborators, such as the Environmental Protection Agency and Department of Energy, in supporting this objective."*



*– Honorable Katherine Hammack, Assistant Secretary of the Army for Installations, Energy and Environment*

*"For the last 20 years the NDCEE has played a critical role in supporting the DoD as it addresses high-priority ESOHE challenges in a dynamic environment. The technologies we have explored, validated, and transitioned provide high-impact solutions that enhance sustainability and security, expand operational effectiveness, reduce lifecycle costs, protect warfighters, and increase readiness. Our continued support of stakeholders across the DoD will facilitate their transition from a decade of war footing to the agile, flexible force of the future, ready for a full range of contingencies. I invite you to explore and leverage NDCEE expertise and capabilities as reflected in our FY11 successes, in addition to the many collaborative opportunities for addressing emerging ESOHE challenges."*



*– Hershell "Hew" E. Wolfe, Deputy Assistant Secretary of the Army (Environment, Safety, and Occupational Health)*

Since 1991, the National Defense Center for Energy and Environment (NDCEE) has served as a national leadership organization to address high-priority environmental, safety, occupational health, and energy (ESOHE) challenges for the Department of Defense (DoD), other government organizations, and the industrial community.

The NDCEE's mission is to support DoD sustainability and readiness through:

- Research, development, and test efforts to identify available ESOHE alternatives
- Demonstration, validation, and transition of technologies to defense installations, industrial activities, and private industry
- Training that supports the fielding of new, validated technologies

### Photo Credits

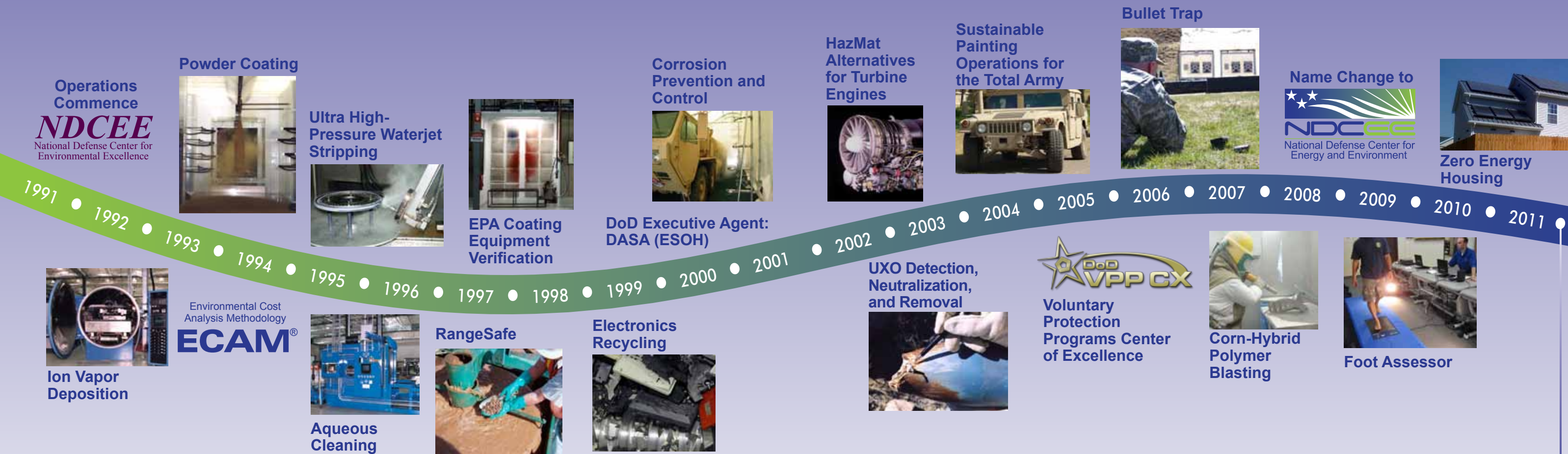
Page 6 - air traffic controller, U.S. Air Force. Page 8 - solar power, U.S. Army. Page 12 - pumping system, U.S. Army photo by Rachel Parks, III Corps and Fort Hood Public Affair. Page 13 - ship, U.S. Navy. Page 14 - M1A2 assembly, U.S. Army. Page 15 - ammunition, U.S. Army. Page 17 - hydraulic hose, U.S. Air Force. Page 18 - soldiers, U.S. Army. Page 19 - training, DoD; soldier 360 - U.S. Army. Page 20 - helicopter, U.S. Air Force.



**DoD Executive Agent**  
**Office of the Assistant Secretary of the Army**  
**for Installations, Energy and Environment**



# 20 YEARS OF NDCEE



## FISCAL YEAR 2011

### Enhancing Sustainability and Security

Recognizing that sustainability and security go hand-in-hand, the NDCEE assists DoD in pioneering new ways to monitor and reduce its water and energy demand, protect vital natural resources and explore alternative energy sources, and reduce waste generation. Among the FY11 milestones, the NDCEE explored various tools and best management practices to reduce air and water compliance burdens and tested a prototype technology to facilitate treatment of scrap on active and formerly used ranges. Addressing challenges faced by Army, Navy, Air Force, and Marine Corps installations both at home and abroad, the NDCEE demonstrated numerous renewable energy and waste-to-energy (WTE) technologies, as well as potential solutions to conserve potable water and reclaim off-spec fuel for reuse. By promoting sustainable technologies and best practices, the NDCEE ensures that the DoD of tomorrow will have access to the resources required to support our operational forces.

### Optimizing Performance While Reducing Lifecycle Costs

The NDCEE remains a key ally of the DoD industrial base; enhancing the sustainability and efficiency of manufacturing and maintenance operations, while reducing lifecycle costs. In FY11, the NDCEE continued to minimize environmental impacts and operational costs associated with ammunition production through tools that engage industry and promote competition, as well



*Ms. Helen Reed-Rowe, the first U.S. Ambassador to the Republic of Palau, participated in the ribbon-cutting ceremony for the photovoltaic system installed and demonstrated at Camp Katuu.*

as facility improvement analysis. Several innovative materials and technologies also were demonstrated and validated to eliminate hazardous materials from weapon systems maintenance operations. This included hands-on joint service demonstrations of several biobased products. With the NDCEE's continued assistance, DoD stands to increase awareness and use of sustainable and environmentally preferred products that meet federal criteria and perform reliably in the warfighting mission.

### Protecting Warfighters, Preventing Mishaps, and Promoting Readiness

In FY11, the NDCEE continued to advance technologies and best practices that prevent mishaps and protect the physical and mental health of the warfighter. For example, state-of-the-art technologies to mitigate aircraft mishaps by reducing risks in degraded visual environments and others designed to protect soldiers from improvised explosive device (IED) attacks, were explored. The NDCEE also continued to transform the military culture through the Voluntary Protection Programs Center of Excellence (VPP CX) and demonstrated a variety of tools and training to increase warfighter performance, fitness, and overall well-being. These NDCEE efforts yielded continued progress toward meeting the Secretary of Defense's challenge to reduce mishaps by 75%, avoid an estimated \$10–\$21 billion in preventable injuries and illnesses, and assure DoD's operational readiness, agility, and strength.



*The NDCEE, Office of the Secretary of Defense (OSD), and Defense Logistics Agency (DLA) shared the 2011 Achievement in Inauguration Award from the Center for Environmental Innovation and Leadership for the Green Product Evaluation and Demonstration Program.*



# OPERATIONAL STATISTICS

The NDCEE celebrated its 20th Anniversary during FY11, and we continue to successfully accomplish our mission: identifying, demonstrating, evaluating, and fielding technologies in support of DoD readiness, sustainability, and the warfighter.

51

task orders completed in FY11


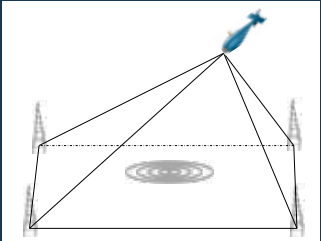

Fifty

task orders awarded increasing total dollars on contract by

\$56.7M

# TECHNOLOGY TRANSITIONS

The NDCEE performs value-added activities to advance the technology readiness level (TRL) of potential solutions in all phases of the transition process – Assessment, Development, Demonstration/Validation, and Transition.

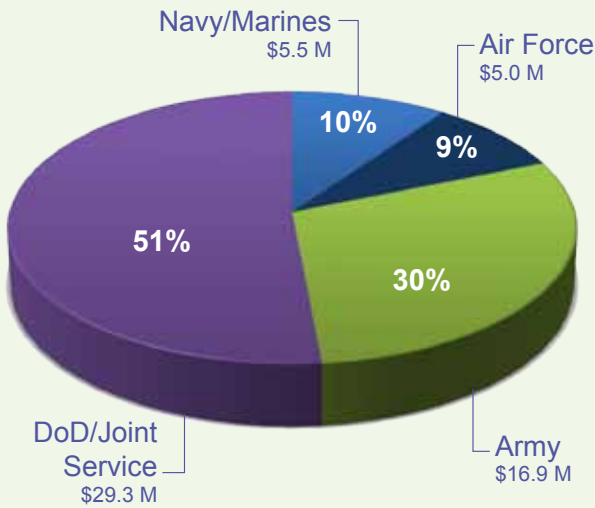
Assessment (TRL 1-8)	Development (TRL 1-5)	Demonstration/ Validation (TRL 6-8)
<p>Literature searches, data mining, surveys, and other methods are employed in this phase to ensure problem context, drivers, and end-user needs; obtain available technical, economic, and ESOHE data on current and alternative technologies; and focus technology transition efforts.</p>  <p>Cadmium and Hexavalent Chromium Free Electrical Connectors</p>	<p>This phase includes those activities involved in the evolution of scientific concepts and research towards tangible technical solutions, including: preliminary design, system or process development and fabrication, computer modeling, and bench-scale or laboratory testing.</p>  <p>Green Automated Munitions Evaluation and Recovery System (GAMERS)</p>	<p>This phase includes activities associated with testing and evaluating potential technology alternatives against user requirements. Whether at the prototype or full-scale, demonstration/validation can encompass a variety of evaluation objectives including feasibility, optimization, and/or operational acceptance testing.</p>  <p>Photovoltaic (PV) Systems</p>

52.9%

of subcontracted dollars to date awarded to small businesses

# MORE THAN 100 CLIENT AND STAKEHOLDER ORGANIZATIONS SERVED

Averaging 123 client deliverables per month, the NDCEE maintained an average on-time delivery greater than 99%. To ensure that pertinent technical information from NDCEE projects is widely shared, 212 deliverables were uploaded to the Defense Technical Information Center (DTIC).



The NDCEE is working across the Army, Navy/Marines, Air Force, and DoD. This chart shows the percentage of FY11 contract awards supporting each client.

# Outreach Activities

NDCEE outreach activities directly support technology transition by disseminating information on ESOHE technologies to audiences within the DoD and across other federal agencies. Extending the base of knowledge is an important part of the NDCEE's mission.

# CONFERENCES

Exhibited and presented at

seven

ESOHE conferences

Technology demonstrations were featured in the NDCEE booth and subject matter experts contributed

20

technical presentations and posters.

156

participants from government and industry attended the NDCEE Program Conference held on June 14-16, 2011

# PUBLICATIONS

FY10 Technologies Publication • Fall/Winter Newsletter • Task Descriptions • Technology Fact Sheets • Four articles featuring NDCEE accomplishments submitted to military and technical journals

MarCom Platinum and Gold Award Winners  
Capability Summary • Spring/Summer Newsletter • FY10 Annual Report


www.ndcee.ctc.com

13,000


visits to the site per month, on average

Transition  
(TRL 9)

The final phase may include implementation, start-up, training, and/or other support efforts necessary to field validated technologies for installation and weapon system end users. Now the technology is ready for operational military use at the end user's discretion.



**Advanced 3D Safety Training**  
A training playback on demand (pod) system was transitioned to the Washington Headquarters Service for use in training Pentagon personnel.




**Alertness Management in Military Operations**  
AMMO was deployed to registered users in a variety of electronic formats to help them predict and manage fatigue.



**Biobased Products**  
Following demonstrations at Joint Base Charleston, SC, the DLA issued four National Stock Numbers (NSNs) for biobased penetrating lubricants and two NSNs for new biobased sorbents.



**Distributed Wind Turbine**  
A 1 kilowatt (kW) wind turbine was transitioned to Forest City Military Housing, HI, following a technology demonstration.



**HAP-Free Cleaning and Degreasing**  
Two ultrasonic cleaning systems were installed at Anniston Army Depot: a small arms cleaning system in Building 129 and a plating wax removal system in Building 114.



**Lead-Free Electronics Impact Training**  
A web-based training module, Lead-Free Electronics Impact on DoD Programs, was added to the Defense Acquisition University.



**PV Arrays**  
Following results of the year-long demonstration/validation that exceeded expectations, two PV arrays installed atop a parking structure were transitioned to Fort Hood, TX.



**Water Conservation System**  
Components of a system that transfers water from Landfill Lake to irrigate the installation's golf course were designed and installed at Fort Hood.





Chesapeake Bay Total Maximum Daily Load Pilot Approach • Densification • Deployable Waste-to-Energy

# ENHANCING SUSTAINABILITY AND SECURITY

National security and the long-term viability of our military depend on transitioning to more sustainable methods to fulfill the DoD mission. With support from the NDCEE, the DoD is strategically moving toward a more sustainable, secure future where the warfighter of tomorrow is trained and equipped at a lower cost than the warfighter of today, and our nation's natural resources are preserved for future generations. The ability to provide energy where and how our forces need it is critical to our national security and operational readiness, but energy supply chains represent one of the greatest vulnerabilities to troop protection. Similarly, the need for potable water and proper waste management pose security challenges both at home and abroad. In FY11 the NDCEE supported a number of energy, water, and waste reduction efforts to assist the DoD in achieving a 'NetZero' future.

System • Diesel Fuel Reclamation • Direct Alkaline Fuel Cell • Distributed Wind Turbine • Energy Dashboard

## PROTECTING OUR VALUABLE NATURAL RESOURCES

As our military forces maintain national security and operational readiness, they must consider the environment, creating a culture of stewardship that protects our valuable and limited natural resources both internationally and domestically. In support of U.S. Southern Command and U.S. European Command, the NDCEE supports research, analysis, and information exchange on regional environmental, energy, and sustainable development issues and opportunities. Facilitating multi-national technical workshops, the NDCEE allows the DoD the opportunity to demonstrate a commitment to environmental stewardship in a context outside our national borders and collaboratively address common environmental and security challenges.

Domestically, the NDCEE is piloting an approach that could significantly benefit a key natural asset, the Chesapeake Bay Watershed, and reduce the compliance burden of federal installations in that region. The Environmental Protection Agency promulgated the Final Chesapeake Bay Total Maximum Daily Load (TMDL) that applies to surface waters discharging to the bay from portions of six states and the District of Columbia. The TMDL provides a "pollution diet" to limit the contributions of pollutants from point and nonpoint sources within the impaired watershed. The NDCEE developed a transferable process using Geographic Information Systems to compile land use data in conjunction with TMDL modeling to prioritize compliance opportunities. This staged procedure was employed in pilot studies at several Army installations within the Chesapeake Bay



*The NDCEE is working with five pilot Army installations to assess current and potential future best management practices that can reduce discharge of contaminants to the sensitive 64,000 square mile Chesapeake Bay Watershed and reduce the cost of compliance with TMDL requirements.*



Watershed. As a result, recommendations for interfacing with regulatory agencies for TMDL compliance were developed, as were a guidebook and training presentation. These materials and best practices have been leveraged by the National Park Service and could be transferred to any DoD or other federal agency site in the region. Enabling DoD and other government facilities to calculate their own point and nonpoint source loads will allow them to knowledgeably discuss their Chesapeake Bay TMDL compliance with regulatory agencies and negotiate compliance effectively, based on accuracy of land use data and/or credits for best management practices.

Further minimizing the DoD's compliance burden, the NDCEE tailored an air quality compliance solution as part of a demonstration of a web-based Environmental Management Information System (EMIS) for Fort Benning, GA. The Fort Benning EMIS was configured to streamline Title V data collection, compliance management, and reporting. The EMIS modification demonstrated by the NDCEE allowed Fort Benning's 9 source categories and 141 conditions to be managed through a single data entry that supplies regulators with information to satisfy Title V Compliance, Prevention of Significant Deterioration, Greenhouse Gas, and State Emissions Inventory calculations. These efficiencies reduced monthly data entry times from three days to a few hours and report preparation from several weeks to a few hours. As a result of this work, environmental managers can more accurately and efficiently manage air quality on and around Fort Benning.

IMPROVING RANGE SUSTAINABILITY AND SAFETY

Active ranges are critical to maintain a trained and ready force, but contamination concerns can limit long-term use. The NDCEE identified several approaches to prevent and address range contamination and limit the potential exposure of munitions handlers to hazardous constituents. For example, as an alternative to explosive spotting charges, which can contaminate ranges and impose a potential safety hazard, the NDCEE is evaluating the Green Automated Munitions Evaluation and Recovery System (GAMERS) for scoring large caliber ordnance deliveries. GAMERS uses chirped radio frequency with an encoded data link technology to effectively identify impact locations of munitions, provide immediate

feedback to a training unit, and document impacts after ricochet or breaching for later range clearance. If proven, GAMERS would be a cost-effective method to enhance sustainability and maintain training operations on Marine Corps and Army mortar and artillery ranges, as well as Air Force and Navy Air-to-Ground Ranges. The NDCEE also continued development of a prototype system for on-range decontamination of range debris. Working with Battelle Memorial Institute, the NDCEE modified a catalytic hydrothermic unit to create a Modified Decomposition/ Hydrolysis (MDH) system that can treat explosive-contaminated range debris in the field. The resulting scrap metal can be recycled or disposed of as a non-hazardous waste, thereby reducing waste management costs and increasing safe material handling. In FY11, a successful acceptance test, in which the MDH system processed hydrolysate generated from the treatment of up to 10 kilograms of explosives in less than eight hours of operation, verified the functionality of the system.

Finally, the NDCEE researched the toxicity of cyclotrimethylenetrinitramine (RDX), a key military explosive, and its effects on the brain. RDX poses a health risk to range clearance personnel and species from lizards and birds to non-human primates. The NDCEE supported the U.S. Army Public Health Command (Provisional) in identifying the neurotoxic properties of RDX and the mechanism by which it causes seizures. Based on animal laboratory results, RDX replacement candidates such as K10 and K26, or other potential emerging contaminants, can be evaluated for their neurotoxicity in comparison to the RDX baseline. Knowing the mechanism by which RDX induces seizures also guides treatment in cases of RDX overexposure and contributes to the development of drugs that will prevent seizures after exposure.



The portable MDH system was designed to treat explosive-contaminated range scrap in the field. The treated metal can be sold as scrap, diverting hazardous waste into a potential revenue stream.

20% electric utility cost reduction

The NDCEE is tapping abundant tropical sunshine to demonstrate a PV system at Camp Katuu, Palau. Historically, electricity contributed to 33% of Camp Katuu's operating costs, not including costs to fuel the camp's backup generator.



MINIMIZING THE CONTINGENCY OPERATION FOOTPRINT

Because fuel and waste are often significant logistical burdens for contingency operations, the NDCEE is addressing these issues by providing engineering and demonstration support to renewable energy and waste reduction demonstration initiatives. For example, Camp Katuu's reliance on the local (and somewhat unreliable) Palau energy grid offered the NDCEE an opportunity to team with the U.S. Pacific Command to evaluate solar energy as an alternative for the camp. Historically, the camp's peak load costs an average of \$10,000 per month; 33% of the operations budget. The NDCEE designed and installed a PV system and obtained and compiled system performance and economic data for the first three months of monitoring the 42 kW (DC) PV array. Based on these results, it is anticipated the system will reliably meet more than 20% of the total energy load for Camp Katuu, resulting in an anticipated annual cost savings of more than \$25,000. During installation, the NDCEE also trained the 249th Engineering Battalion on installation processes and procedures so this success can be replicated at other DoD locations.

While waste poses risks to human health and the environment, it also represents a potential source of energy. WTE systems simultaneously solve two large logistical burdens for deployed forces, disposing of waste in an efficient and environmentally sound manner while reducing the fuel needed to meet operational requirements. Reducing the fuel and waste logistical burden in turn reduces the potential for insurgent attacks

on convoys. To process waste for use in WTE systems or gasifiers, densifiers compress shredded waste into refuse-derived fuel (RDF) in the form of pellets and briquettes. The NDCEE worked with 11 DoD stakeholder organizations and 18 companies to identify densification technologies that could potentially be applied to military needs. Based on demonstrations by the NDCEE, commercially available densification systems show great promise for military waste reduction and production of fossil fuel alternatives. The NDCEE demonstrated two gasifiers to determine their ability to handle RDF produced from densifiers and concluded that 1.5 to 2 tons of RDF can displace 1 ton of coal.

The NDCEE further improved the Onsite Field-feeding Waste to Energy Converter (OFWEC III), a WTE unit at the Natick Soldier Research Development & Engineering Center. The OFWEC III was field tested at Aberdeen Proving Ground,



During a July 2011 demonstration, the OFWEC III technology reduced the weight of incoming waste by 90% and offset up to 34% of the diesel fuel used to operate a Tactical Quiet Generator.



MD, and Fort Irwin, CA, processing up to 50 pounds per hour of municipal-type waste. The OFWEC gas was then sent to a standard Army-issued 60 kW Tactical Quiet Generator (TQG) adapted to operate on syngas. During the demonstration, OFWEC III reduced the weight of incoming material by 90% while offsetting up to 34% of the diesel used by the TQG – creating an effective alternative for contingency operations, particularly when considering health, logistical, and fuel benefits.

## TARGETING NET ZERO

In an effort to bring the overall consumption of resources and generation of waste down to an effective rate of zero, the NDCEE assists the military in complying with various Executive Orders, policies, and directives that improve environmental quality and strengthen energy security. All Services continue to make great strides toward sustainability objectives, and in taking the next step to promote the integrated concept of 'Net Zero,' the Army has implemented a Net Zero Installations Initiative. In support of these efforts the NDCEE sponsored and assisted in the execution of the first Net Zero Workshop at Fort Detrick, MD. The workshop allowed attendees to participate in on-site energy, water, and waste demonstrations; share preliminary net zero strategies in energy, water, and waste focus groups; discuss issues and needs; and receive tools, resources, and technical information from subject matter experts to support designated Army pilot installations to achieve net zero goals by 2020.

Outside of the Net Zero Installations Initiative, the NDCEE is demonstrating various technologies to help the Army and the other Services meet their sustainability goals. For example, utilizing energy models based on construction materials, building location and orientation, air handling and lighting system designs, and building occupancy and usage, the NDCEE supports green building designs that optimize energy efficiency and occupant comfort. Construction of two such net zero energy homes at Fort Campbell, KY, was completed this year. The project was awarded a Platinum-level certification under the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED™) rating system. Energy modeling also was used to create a baseline for a 440,000 square foot building at the U.S. Marine Corps Maintenance Center Barstow. Using this model, the NDCEE simulated



Fort Hood showcases the new Landfill Lake pumping system that allows storm water runoff from the reservoir to be used to irrigate the Fort Hood golf course, conserving potable water.

the effects that potential facility, equipment, and lighting upgrades would have on energy consumption and the indoor environment. The results of these simulations were used as a basis for recommended sustainable facility improvements.

The NDCEE continues to evaluate and implement renewable energy technologies and water conservation solutions for DoD installations. At Fort Hood, two 5 kW PV systems (monocrystalline and thin film) installed on a carport generated over 17,000 kilowatt-hours the first year of operation, 12% of the associated building's electricity needs. This small-scale effort resulted in an annual reduction of more than 11 tons of carbon dioxide. The NDCEE also supported several wind technology initiatives, including a distributed wind turbine demonstration in Hawaii and a siting analysis conducted at Fort Hood. An empirically based statistical calculation methodology that integrates point-specific wind energy data was applied to identify 20 sites at Fort Hood suitable for wind power development. The NDCEE also determined the electricity rate breakeven point under multiple scenarios that would be needed to make sound wind power investment decisions. In addition to these renewable energy initiatives, the NDCEE assisted Fort Hood with designing and testing a system for using nonpotable water for irrigation. A pumping station (running on biodiesel) was installed at Landfill Lake and integrated with the base-wide water supply delivery system to water the golf course and meet the potable water reduction goal of 2% per year.

Like the other Services, the Navy is pursuing sustainability and cost-saving opportunities for its installations, ship

# \$10M

possible annual savings

*In an NDCEE demonstration at the Manchester Fuel Depot, contaminated diesel fuel was successfully recycled, potentially allowing the Navy to offset the purchase of four to six million gallons of new fuel annually at a single depot.*

systems, and air fleets. Just one of many examples, reclaiming off-specification diesel fuel from Navy vessels could save one depot more than \$10 million annually. Each year, the Manchester Fuel Depot (MFD) manages four to six million gallons of residual fuel from Navy vessels being prepared for overhaul or decommissioning. This fuel cannot be placed back into defense fuel stocks because it is often contaminated with sediment, water, and/or lower grade petroleum constituents. The NDCEE identified existing market-ready fuel reclamation technologies and demonstrated three systems on a pilot scale at the MFD: an algae-X process, an oil filtration system, and an advanced membrane separation system. Based on performance and cost criteria, the NDCEE recommended oil filtration technology as the most promising for the reuse of contaminated fuel, thereby offsetting the consumption of new fuel. Nearly every shipyard and all fuel depots receive and process large amounts of contaminated naval fuel. As a result of this demonstration, the NDCEE produced a demonstration protocol, analytical results, and a cost benefit analysis that can be used to justify further evaluation of full-scale fuel reclamation technology for other Navy and DoD sites.

In addition to demonstrating and transitioning solutions for energy conservation and use of renewable energy sources, the NDCEE has also supported the DoD in developing tools and resources that enhance energy management. Spending more than \$8 billion dollars on energy for aviation, ground vehicles, and facilities in FY10, the Air Force is the largest consumer of energy in the entire federal government. Because energy is vital to its mission, the Air Force has established a comprehensive

Energy Plan built upon three pillars: reduce demand, increase supply, and change the culture. In support of the Air Force Energy Plan, the NDCEE developed, demonstrated, and determined the effectiveness of an interactive dashboard to collect, analyze, and report on energy metrics. The resulting Enterprise Energy Dashboard tracks metrics for aviation, facilities, ground vehicles, acquisition, outreach and partnerships, and operational metrics - making enterprise energy management possible.



*The Enterprise Energy Dashboard provides energy awareness at all levels of an organization – from senior leaders looking across the enterprise, to Major Command or Base Commanders, to functional-level stakeholders evaluating energy within a specific domain.*

Open Burn Emission Factor Methodology • Photovoltaics • Solar Thermal Radiant Floor Heating • Virtual Building Energy and Environment Modeling • Water Conservation System

*"The Net Zero Initiative is to be a force multiplier enabling the Army to appropriately steward available resources, manage costs, and provide our Soldiers, Families and Civilians with a sustainable future."*

– Honorable Katherine Hammack, Assistant Secretary of the Army for Installations, Energy and Environment





Biobased Products • Biodiesel in Tactical Vehicles • Brass Ammunition Testing Alternatives to Mercurous Nitrate • Corrosion Prevention and Control Improvements • HAP-Free Cleaning/Degreasing • Oven Heating for Removal of Cosmoline

## OPTIMIZING PERFORMANCE WHILE REDUCING LIFECYCLE COSTS

As facilities age and federal and state regulations become more stringent, the DoD must modernize its industrial base while taking advantage of opportunities to optimize performance, enhance sustainability, and reduce costs. Likewise, as new weapon systems are designed and the operating life of legacy systems continues to be extended, the NDCEE looks for opportunities to improve ESOHE aspects in each phase of the acquisition lifecycle. The NDCEE partners with DoD stakeholders to identify and implement innovative solutions for sustainable manufacturing and weapon systems maintenance based on mission performance, cost savings, and reduced lifecycle impacts. What started as 'Green Manufacturing' 20 years ago has grown into an NDCEE core capability: to engineer, demonstrate, validate, and field sustainable technologies and green products across the DoD.

### DRIVING SUSTAINABILITY THROUGHOUT THE ACQUISITION LIFECYCLE

The Army's ammunition plants are challenged with providing an adequate ammunition supply and decreasing production costs, while Army depots are challenged with safely demilitarizing and disposing of the growing stockpile from military operations. The NDCEE has engaged with ammunition plants to facilitate increased competition, assess and implement more sustainable processes, modernize critical infrastructure, and ultimately reduce acquisition lifecycle costs. At the Lake City Army Ammunition Plant (LCAAP), virtual and physical technical libraries were developed with facility and production information to promote cost effective operations and allow additional industry partners to compete for ammunition production work. In a related effort for the Program Executive Office Ammunition, the NDCEE consolidated manufacturing and supply chain data for nitrocellulose, candle production, M795 melt/pour, and the Hydra 70 rocket system, saving time and reducing the risk of production interruption. The NDCEE also collaborated with the Project Director for Joint Services to establish a methodology that would enable the Army to share in the savings generated as a result of more than \$1.4 billion invested in production base modernization projects – ultimately reducing the price the government pays for ammunition.

One of the NDCEE process improvement efforts focused on enhancing sustainable ammunition production has the potential to eliminate mercurous nitrate ( $\text{HgNO}_3$ ) from LCAAP's stress corrosion crack testing process. Current processes for testing brass ammunition cases expose personnel to mercury, and both the test cases and spent solution must



*The NDCEE is addressing lifecycle challenges in ammunition production and demilitarization through sustainable modernization efforts to ensure warfighters are always equipped to train and fight. We are engaged at the Program Executive Office, Project Director/Manager, and individual ammunition plant level to effect material, process, and operational improvements.*



be disposed as hazardous waste, which is costly. The NDCEE identified three alternatives to mercurous nitrate and conducted bench-scale testing on brass cases from LCAAP production lots. Ammonia vapor testing not only exposed stress cracks, but did so after 2 hours of immersion instead of the 12 hours routinely used in industry. The NDCEE investigated how the alternative test could be integrated into the LCAAP production environment using existing facilities.

On the other end of the acquisition lifecycle, the Product Manager Demilitarization strives to reduce the growing demilitarization stockpile by 6% per year. However, the NDCEE determined that the DoD has diminishing process capability needed to meet its reduction goal. To address this, the NDCEE identified and prioritized opportunities for investments in demilitarization processes that will reduce costs and optimize throughput and performance. This independent assessment led to the development of a seven-year investment strategy, emphasizing closed disposal and resource recovery.

GREENING WEAPON SYSTEMS MAINTENANCE

Source reduction via transition to alternative materials and processes reduces the use of hazardous materials in military maintenance activities. This not only enhances sustainability, but in many cases green alternatives improve efficiency and effectiveness and reduce costs. For example, ultrasonic cleaning systems transitioned to Anniston Army Depot (ANAD) eliminated trichloroethylene (TCE), a potential human carcinogen, from one of its maintenance processes. The NDCEE worked with ANAD, Army Research Laboratory, and the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC) to conduct six bench-



NDCEE personnel adjusting the voltage and amperage (left) and reactor flow (right) settings on an electrocoagulation unit, one of four treatment technologies evaluated to remove cadmium from wastewater at LEAD.

scale demonstrations and recommend the most viable technology for demonstration and evaluation at ANAD. Two dual-frequency ultrasonic cleaning systems were designed and installed; one for cleaning and degreasing small arms components and one for removing plating wax from engine components. The NDCEE validated that ultrasonic cleaning provides a superior clean and degrease compared to the baseline TCE process, particularly in removing fouling from internal cavities and enhancing oxidation removal and prevention.



By reducing hazardous material usage, hazardous waste disposal, and permitting costs for control equipment, ultrasonic cleaning systems are estimated to save ANAD approximately \$42,000 per year.

While sustainable alternatives to cadmium and chromium continue to be evaluated for critical applications, depots must comply with environmental and occupational health regulations associated with the use of these heavy metals. Letterkenny Army Depot (LEAD) teamed with the NDCEE to reduce cadmium levels in process wastewater and ensure compliance with the depot's discharge limits under the Clean Water Act. Four treatment alternatives were identified to reduce LEAD's cadmium discharges: electrocoagulation, ion exchange, chemical precipitation using sodium borohydride, and chemical precipitation using ferric chloride. The NDCEE conducted bench-scale testing to identify effective treatment parameters; configured and operated pilot treatment systems; and collected field data and samples for laboratory analysis to down-select the best alternative. Based on performance data and cost comparisons, the team recommended chemical precipitation using ferric chloride, which could result in an annual savings of approximately \$16,000 and allow LEAD to continue operations in compliance with regulatory requirements.

500

biobased products evaluated

The Green Product Evaluation and Demonstration Program won national recognition. Supported by NDCEE, demonstrations of biobased penetrating lubricants and sorbent products at 13 Tri-Service installations, led to the establishment of NSNs and increased DoD-wide availability.



To keep vehicles in the field longer between depot maintenance visits, the NDCEE teamed with the TARDEC Special Programs Office to identify non-paint alternatives to traditional camouflage paint. A vinyl wrap solution borrowed from the car racing industry not only reduces application time, waste, and material costs, but also eliminates exposure of personnel to hazardous air pollutants and volatile organic compounds. Two types of graphic media and one over laminate were selected for demonstration. Terrain and season-specific camouflage patterns were generated using fractal-based pattern-generation algorithms applied to a background image of natural scenery – increasing pattern options beyond those that can be applied with paint. Vinyl wraps are rapidly deployable and allow soldiers to change patterns in the field without specialized facilities; multiple layers with different patterns can be installed on vehicles and removed to provide camouflage for changing seasons or terrains. Delivering wraps to vehicles in theatre instead of transporting vehicles to maintenance facilities with paint booths would also save transportation costs and personnel time.

INTRODUCING GREEN PROCUREMENT OPTIONS

The Federal Acquisition Regulation requires federal agencies to procure biobased products; however, biobased products must be validated against performance standards before they enter the supply chain. The NDCEE helped the DoD increase usage of sustainable products by demonstrating and validating the performance of biobased lubricants and sorbents, biodiesel in non-deployed tactical vehicles, and other products used in weapon systems maintenance and operations. Utilizing the green products database developed by the NDCEE,

the team collected technical data on biobased products that meet government specifications and conducted field demonstrations for biobased penetrating lubricants and sorbent products at 13 Army, Air Force, Navy, Marine, and/or Joint installations. As a result of these demonstrations, DLA established new NSNs for both biobased penetrating lubricants and biobased sorbents, making them available for DoD-wide procurement. Given their hands-on experience, several of the installations participating in the demonstrations plan to transition to the biobased alternatives as inventories are replenished.

The NDCEE is also demonstrating and validating the performance of biodiesel in non-deployed tactical vehicles, driven by requirements for using biobased fuels in the Energy Independence and Security Act. Ultimately, these results will help commanders decide how to use biodiesel blends by providing data from the field on biodiesel stability, accelerated deterioration in high temperature environments, vehicle operation and fuel properties in low temperatures, water affinity and microbial degradation, and material compatibility. The NDCEE evaluated B20 biodiesel (20% biodiesel and 80% petrodiesel) in non-deployed tactical vehicles and equipment at six test sites spanning all military branches and captured data on biodiesel performance in different climates from Hawaii to Indiana. The results of this investigation indicated that specification quality B20 may have applications in select, frequently operated, tactical vehicles in moderate climates without a significant impact in the cost of fleet operation or performance. In fact, as a result of their participation in the demonstration, Marine Corps Base Hawaii installed a 12,000 gallon storage tank to supply B20 to their white fleet with the potential to expand to other vehicles in the future.





Advanced 3D Safety Training Technologies • Alertness Management in Military Operations System • Brownout Landing Aid

# PROTECTING WARFIGHTERS, PREVENTING MISHAPS, AND PROMOTING READINESS

Operational readiness is enhanced significantly by best practices in everyday military and civilian activities that reduce risk, avoid mishaps, and maximize the physical and mental resiliency of the warfighter – all while creating a culture of safety, both on- and off-duty. Developing and promulgating these best practices in partnership with the Defense Safety Oversight Council (DSOC) and VPP CX, the NDCEE conducts data-driven research, demonstrates cutting-edge technology, and supports initiatives that promote a pervasive safety culture. Use of these best practices serves to elevate service members to a peak level of performance, ensuring a maximum number of deployable forces in executing the DoD mission.

System Technology • Defense Safety Enterprise System • e-VPP Tool • Foreign Object Damage Detection and Removal System

## IMPROVING HEALTH, SAFETY, AND WELL-BEING

Training service members who are mentally and physically prepared for engagement in theater goes hand-in-hand with taking necessary precautions to prevent mishaps and injuries. The NDCEE is developing and demonstrating best practices and technologies to ensure safety, readiness, and adaptability of the warfighter and DoD civilians who support them. An optimal and consistent level of Basic Combat Training (BCT) is required to prepare the warfighter for the rigors of military service. However, overtraining can contribute to musculoskeletal injury. Supporting the DSOC and its Military Training Task Force, the NDCEE developed a detailed, high-resolution dataset describing the quantity of recruits' physical activity and observed patterns during the 10-week BCT course at two basic training posts. The dataset will be further analyzed by the U.S. Army Research Institute of Environmental Medicine (USARIEM) for differences between training companies, as well as between planned and actual recruit physical activity. This analysis will enable the examination and determination of associations between physical activity, injuries, physical fitness, and other factors, thereby improving the predictive capacity of the Training, Overuse Injury and Performance model employed by USARIEM.

While top-down management and oversight of individual health, safety, and fitness remain critical components of operational readiness, the NDCEE recognizes the importance of arming warfighters with tools, training, and information that allow them to take greater control of their own physical and emotional well-being. Soldier 360



*Overuse injuries incurred during BCT can result in delayed graduation, attrition, and significant medical expenses, ultimately limiting the number of deployable service members. The NDCEE is supporting improved analysis and mitigation of BCT injuries based on recruits' physical activity patterns observed at two basic training posts.*



*In Soldier 360 Comprehensive Fitness Training NCOs with combat exposure learn to maintain their own mental, emotional, and physical health so they can better care for the needs of the soldiers they command.*



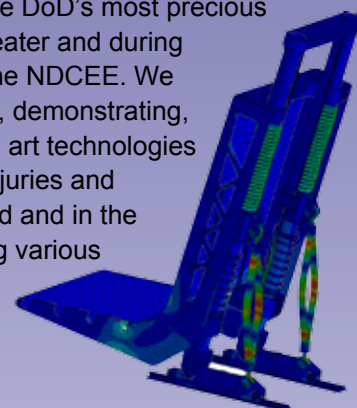
is a multidisciplinary commander's health and wellness leadership course bringing together valuable mental, emotional, and physical support in a unified delivery system targeting senior non-commissioned officers (NCOs) with combat exposure. By initially targeting NCOs (E-6 and above) and equipping them with the awareness, insight, and skills to better lead and support their soldiers, Soldier 360 positively impacts the health and wellness of the entire unit. In FY11, more than 270 Soldier-Leaders who supervise over 5,500 soldiers and civilians were trained in the course. As part of Soldier 360, participants learn various methods to address stress-management, spinal-injury prevention, relationship-building, and preventing and recovering from Post Traumatic Stress Disorder. Follow-up surveys show participating soldiers continue to apply Soldier 360 skills long after course completion, resulting in increased unit productivity, better home and family relationships, and improved stress management.

During times of high operational tempo, limited or poor quality sleep critically reduces individual mental and physical responses, which raises the risk of mishaps and injuries, as well as costly damage to equipment and operational objectives. The NDCEE implemented a suite of software tools, known as Alertness Management in Military Operations, to reduce fatigue-induced mishaps. These tools support individual and team management decisions by enabling users to assess crew and mission schedules for signs of performance degradation and then optimize shift schedules to guard against crew fatigue. One of the tools, the Work Awake application, empowers supervisors to select workers with optimum effectiveness for critical operations, thereby ensuring greater safety and mission success by preventing fatigue-driven mishaps and operational mistakes. The NDCEE also developed a personal-use fatigue application for Android and iPhone users called "miAwake" (pronounced "Am I Awake") that allows users to estimate their operational readiness based on a daily sleep diary. The application informs user decisions and educates them on how sleep can impact their daily effectiveness, which directly correlates to mishaps. Daily logging of sleep allows the model to calculate an effectiveness forecast showing when fatigue is impairing the user's ability to work safely.



## INCREASING CREW SURVIVABILITY AND PREVENTING VEHICLE AND AVIATION MISHAPS

Our military personnel are the DoD's most precious asset, and saving lives in theater and during training is a major focus of the NDCEE. We are committed to developing, demonstrating, and transitioning state-of-the-art technologies to reduce risk and prevent injuries and loss of life both on the ground and in the air. The NDCEE is evaluating various seat technologies with the potential to increase crew survivability in incidents as diverse as vehicular IED attacks and helicopter collisions. For example, the NDCEE is supporting the U.S. Army Tank-automotive and Armaments Command Life Cycle Management Command to improve warfighter survivability through the design, development, and demonstration of a blast-mitigating occupant seat system for military vehicles encountering IEDs. The test seat features an energy attenuation system and a reset mechanism, protecting the occupant during both the initial blast and subsequent impact with the ground. The device will be presented to military Program Executive Offices for use in various new and modified ground vehicles. Similarly, the NDCEE is supporting the Air Force Research Laboratory in developing a repeatable protocol for testing the survivability value of seating in the Navy SH-60B/F/H aircraft. In the test, the NDCEE is using manikins to replicate various-sized occupants in crash simulations.



*Finite element analysis stress contours for the NDCEE blast-mitigating seat design*

While mishaps involving helicopters are some of the most costly and deadly, they are also among the most



*Controlled flight into terrain caused by degraded visual environments, such as dust kicked up by a helicopter's rotors, can be mitigated by NDCEE-demonstrated technologies like the HTAWS that increase a pilot's situational awareness.*

# 58%

## reduction in aviation Class A mishap rates

*The NDCEE demonstrated several state-of-the-art technologies to prevent aviation mishaps, including the TSAS, which features a man-machine interface that provides real-time tactile feedback to pilots for immediate corrective action.*

preventable. A report by the Assistant Secretary of Defense for Research and Engineering on helicopter survivability states that 80% of helicopter mishaps are due to non-hostile action, of which 35% are attributable to degraded visual environments, dynamic rollovers, hard landing, or object strike. Preventing mishaps during helicopter brownout, where dust kicked up by spinning rotors restricts visibility and disorients pilots, is a key DSOC focus area. The NDCEE, supporting DSOC, demonstrated potential solutions to reduce the disorienting effects of brownout during approach and landings in operationally relevant desert environments. Several technologies incorporating 3D synthetic images, a Global Positioning System, Forward Looking Infrared, night vision capabilities, and high resolution imagery to improve rotor wing safety through better spatial awareness were flight tested. Pending final validation and available funding, several prototypes are expected to move to the next stage of DoD implementation, including the possibility of a Joint Capability Technology Demonstration. One very unique technology demonstrated with the potential to prevent helicopter mishaps caused by degraded visual environments is the Tactile Situation Awareness System (TSAS). By interfacing with an aircraft's threat warning, navigation, attitude, and terrain avoidance systems, TSAS provides aircraft position, drift cues, and altitude advisories to pilots via sense of touch by activating a series of vibrating tactile stimulators called "tactors." The stimulus varies in intensity based on the distance from the intended altitude or position. This tactile information is intuitive, reduces pilot cognitive workload, enhances situational awareness, and serves as a new tool in preventing aviation mishaps caused by spatial disorientation. A TSAS



portable simulator was showcased at various installations, tradeshow, and events to increase awareness of the technology throughout the DoD flying community.

Finally, even the debris-free status of runways can greatly enhance aviation safety and reduce Foreign Object Damage (FOD) costs, estimated at \$12 billion worldwide. A vehicle-mounted FOD Finder™ that detects, maps, and removes foreign objects as small as nine millimeters was demonstrated at Dyess Air Force Base. Using a radar sensor with video-capture capabilities and on-board data processing, the FOD Finder identified and removed 15,750 foreign objects over the six-month test, achieving a mission capable rate of 98.2% and preventing any FOD-related incidents.

## CREATING A CULTURE OF SAFETY

Preventable injuries and illnesses cost the DoD an estimated \$10–\$21 billion annually, according to the National Safety Council. The NDCEE is supporting the DoD in its efforts to create a culture of safety, which can prevent injuries and illnesses, promote service member health, and control costs. For example, to improve safety data management and decision support, the NDCEE has continually enhanced the web-based Defense Safety Enterprise System (DSES). The DSES data warehouse now includes additional attributes in casualty, civilian lost time, deployment, military injury, mishap, patient movement, and workers' compensation. In addition, data sets covering the unit and installation levels have been loaded into DSES, resulting in improved queries and reports designed to prevent injuries and promote safety across all Services and defense organizations.

Ground Vehicle Energy Absorbing Seat • Hand-Arm Vibration Reduction Gloves and Tools • Helicopter Terrain Awareness Warning System (HTAWS) • Improved Non-Lethal Technologies • Integrated Laser Detection and Ranging



3,150  
users worldwide

*Used at more than 320 DoD installations across the globe to provide military departments with an enterprise view of their safety and occupational health performance, the web-based e-VPP Tool won the 2011 Technology Product of the Year award from TECHQuest Pennsylvania.*



The DoD's safety culture continues to evolve, in part due to the positive momentum of the Voluntary Protection Programs (VPP), in which the Occupational Safety and Health Administration (OSHA) recognizes work sites with exemplary safety and health management systems. Nearly 500 DoD representatives took part in the annual VPP Participants' Association, Inc. National Conference. At this year's event, DoD leadership characterized the significant, ongoing, and positive impact that VPP has had on declining mishap rates and highlighted the increasing emphasis that DoD will place on VPP going forward. The VPP CX supports VPP implementation through on-site and remote assistance as well as the e-VPP Tool, which enables headquarters, major commands, and installations to implement, track, and report their VPP progress electronically. New or recently enhanced features offer annual self-evaluation tools, training aids, and best practices. The advancement of VPP and its values are seen on the ground, where 42 sites within the DoD have earned VPP Star recognition since the VPP CX was formed. Naval Shipyard Pearl Harbor recently received a "re-certification" from OSHA on their VPP Star status. Since starting their VPP journey, Naval Shipyard Pearl Harbor has saved more than \$8 million in workers' compensation costs.

Finally, the NDCEE supported the DoD's ongoing battle against motor vehicle mishaps, both on- and off-duty, with two informative, data-driven studies. The findings will guide further efforts to strengthen the culture of safety and help prevent this costly and deadly drain on military personnel,

resources, and readiness. First, a two-phase study of the causes of military vehicle crashes and an analysis of the severity of resulting personnel injuries found that new, commercially available technology holds the potential to prevent more than 25% of mishaps. Prevention technologies include: forward collision warning systems, emergency brake assistance, rear-end collision avoidance, and rollover stability control systems. In the second study, the NDCEE supported DSOC by identifying, documenting, and evaluating the eight programs currently in use or proposed to be used by the military to reduce personal motor vehicle accidents and deaths among soldiers. The Alive at 25 and Attitudinal Dynamics of Driving courses ranked the highest across the study's eight evaluation categories. The NDCEE used the Alive at 25 course as one of the elements in its motor vehicle training program for more than 2,300 participants at six joint bases. The program featured online registration to collect data on students, customized training modules, and motorcycle events for beginning and experienced riders — all serving to promote a culture of vehicle safety and setting the standard for prevention through education and training initiatives.

**"To receive recognition as a Navy VPP Star Site, we have to pass 81 OSHA requirements. Receiving a VPP Star Site recognition means that SRF-JRMC is one of the Navy's safest commands and that we have a highly effective safety program, program implementation and sustainment, strong leadership and aggressive employee involvement."**

**— Mr. Hitoshi Kato, U.S. Naval Ship Repair Facility and Japan Regional Maintenance Center (SRF-JRMC) Safety and Occupational Health Division Head**



## LOOKING AHEAD

During FY12 and beyond, the NDCEE will continue its critical ESOHE support of the DoD - enhancing sustainability and security, optimizing performance, reducing lifecycle costs, and increasing readiness. Water and energy conservation, renewable energy technologies, and waste reduction best practices will remain priorities in FY12 as the NDCEE contributes to key initiatives, including the Army's Energy Initiatives Task Force and net zero installation activities. Efforts to protect natural resources will continue as the NDCEE develops best management practices and implementation plans for Army installations in the Chesapeake Bay Watershed to meet TMDL requirements. Addressing issues common to many contingency bases, the NDCEE will design and demonstrate an off-grid renewable energy system for Cooperative Security Location Comalapa, El Salvador and will conduct a reusable water study and demonstrate composting at the Navy's Camp Lemonnier, Djibouti. In our continued efforts to address legacy munitions in coastal waters, the NDCEE will build on the successes of the Hawaii Undersea Military Munitions Assessment work to investigate an additional disposal site at Ordnance Reef and two legacy sites along the East Coast.

In FY12 the NDCEE will continue to validate alternative processes and materials for sustainable ammunition production and depot maintenance processes, especially coatings, coating removal, and corrosion control. Beginning with a technical analysis of current and future small arms ammunition needs and production, the

NDCEE will use finite element analysis models to improve manufacturing processes, particularly for green ammunition. The NDCEE will also investigate superhydrophobic coatings - coatings with extreme water repellence - for their potential military applicability. Coating removal will be the focus of an Air Force technology demonstration as the NDCEE validates hand-held laser systems in a production environment and their ability to effectively remove coatings from cargo, fighter, and attack aircraft frames. Finally, to mitigate corrosion of Marine Corps infantry equipment, the NDCEE will design, implement, and validate solutions for improved storage, maintenance, and management of critical warfighter assets.

In addition to continuing to assist DoD installations achieve OSHA Star Status through the VPP CX, the NDCEE will undertake a major industrial hygiene initiative starting in FY12. To support the effective population and use of data in the Defense Occupational and Environmental Health Readiness System, we will develop a data collection protocol and dispatch teams of occupational health specialists to more than 20 CONUS and OCONUS military installations. These industrial hygiene surveys also will be leveraged to baseline the Army's compliance with Quality Work Environment (QWE) criteria. To further facilitate this, the NDCEE will develop and demonstrate a web-based QWE compliance and reporting application.

Going forward, the NDCEE's mission will continue to support the DoD's mission and we will remain a key partner in addressing significant sustainability and readiness challenges.





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